

Construction Engineering & Management

Quality Management

CEM 515

# Root Cause Analysis Enhancement

Term Paper

Jan 21, 2006

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Abqaiq Plants Today film

# Outline

- Part I: Abqaiq Plants Overview
  - Plants Background
  - Plants Processes
  - Plants in Saudi Aramco Organizational Chart
- Part II: Root Cause Analysis Program
  - Initial investigation
  - Review Methodologies
- Summary
- Lessons Learned

## Upset Definition

An unplanned shutdown of critical equipment during normal operation which may lead to production losses.

# Problem Statement

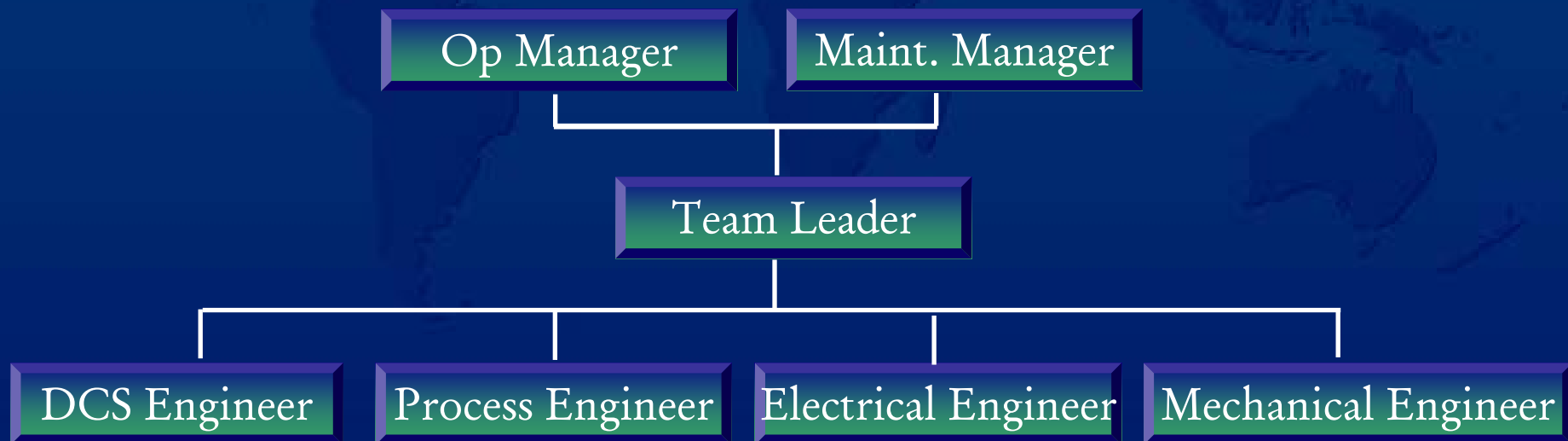
Top Management Statement:

We would like a team to work on identifying the root causes of the nuisance and repetitive upsets!

**We don't want more upsets  
please!**

## Forming Investigation Committee

- Management appointed a leader from Maintenance
- Leader selected members from operations (customer), maintenance and engineering
- Committee members = 5



## Investigation Methodology

Kickoff meeting was started by the team leader and a Weekly meeting was scheduled which lasted for 4 hours

# Investigation Methodology

Initial Review  
of archived reports

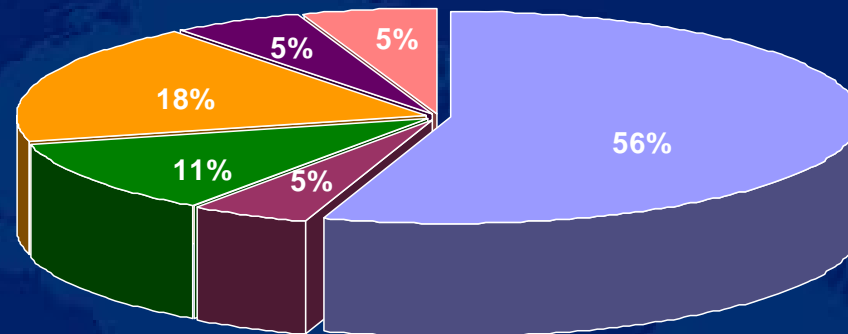
Review of Current  
Investigation system

External  
Benchmarking

Personnel  
Interviews

# Investigation Methodology

- INSTRUMENTATION
- HUMAN ERROR
- ELECTRICAL
- MECHANICAL
- PROCESS RELATED
- UNKNOWN



Initial Review  
of archived reports

Review of Current  
Investigation system

External  
Benchmarking

Personnel  
Interviews



# Investigation Methodology

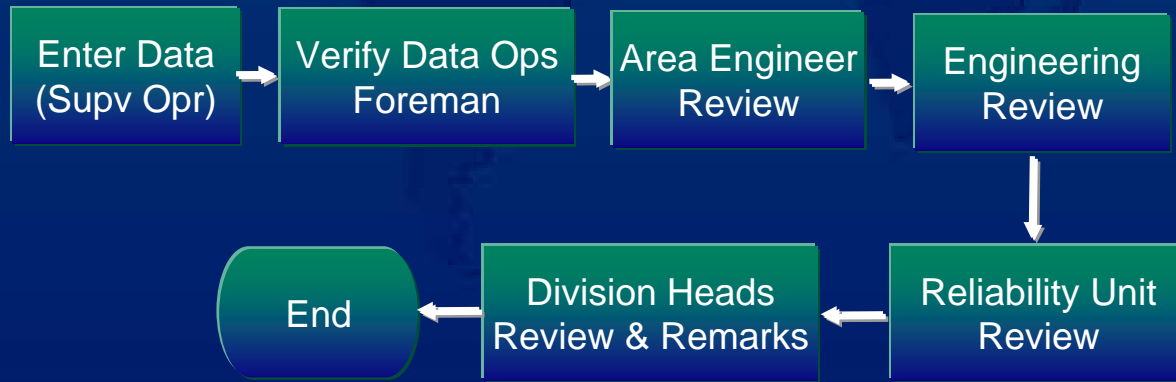
## Investigation Workflow



Initial Review of archived reports

Review of Current Investigation system

## Report Workflow (Manual)

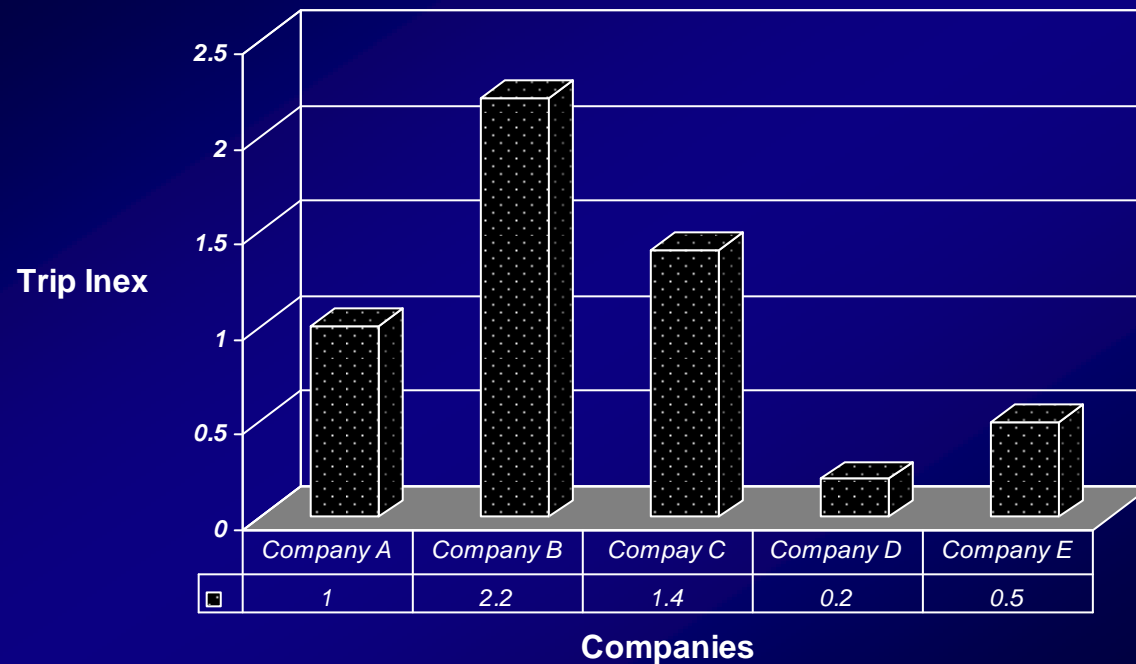


External Benchmarking

Personnel Interviews

# Investigation Methodology

Trip per equipment per year



Initial Review  
of archived reports

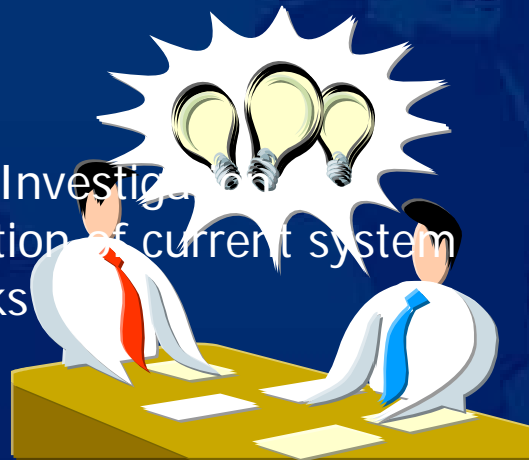
Review of Current  
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# Investigation Methodology

- Current quality of Investigation
- Personnel satisfaction of current system
- Hidden back breaks
- Expectations



Initial Review  
of archived reports

Review of Current  
Investigation system

External  
benchmarking

Personnel  
interviews

# Implementation Roadmap

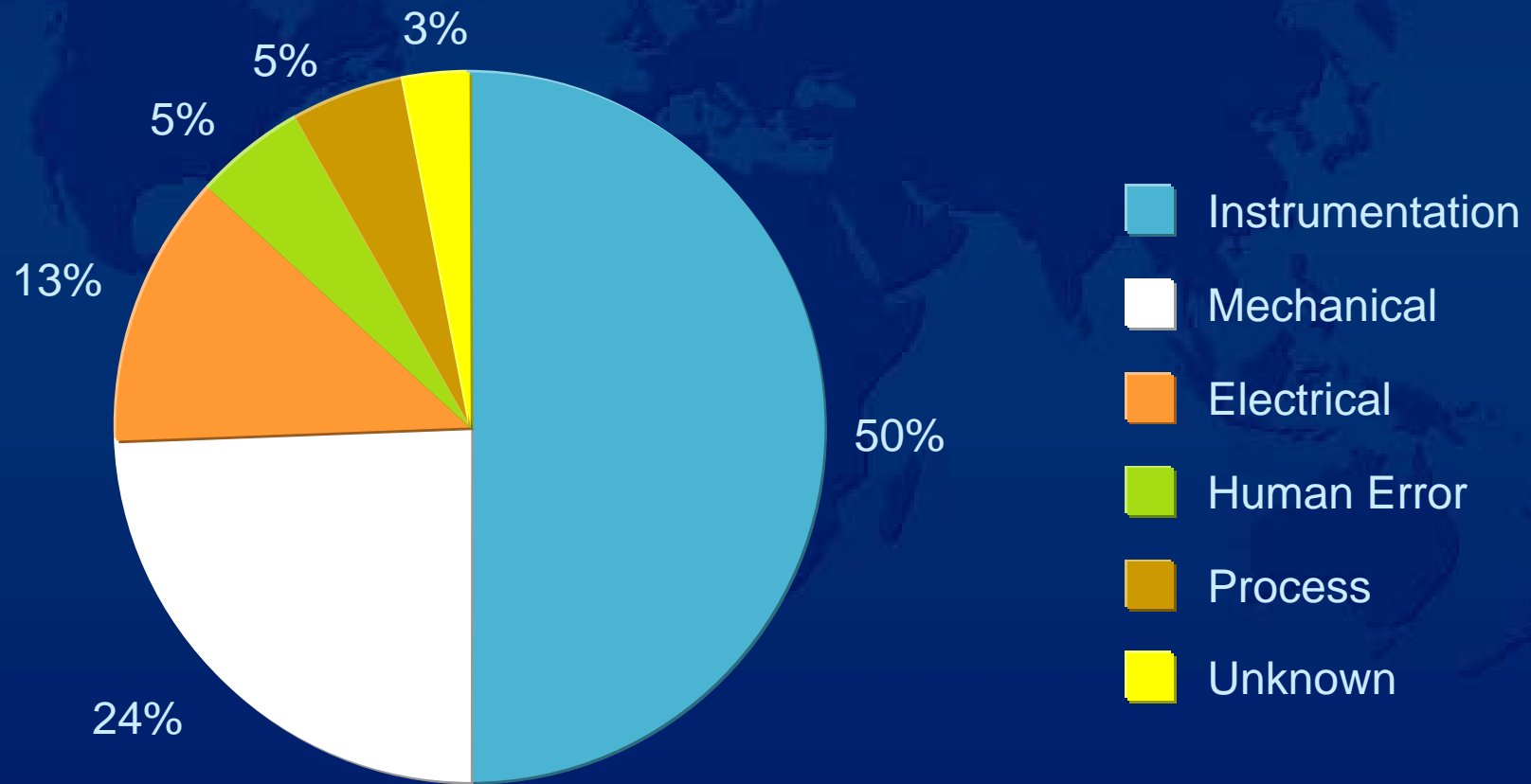


## Quantitative Methodologies

- Identified the data boundaries
- Identified data population = 400
- Gathered all data for 4 years
- Designed Q&D Access Database
- Used Minitab to generate statistical analysis

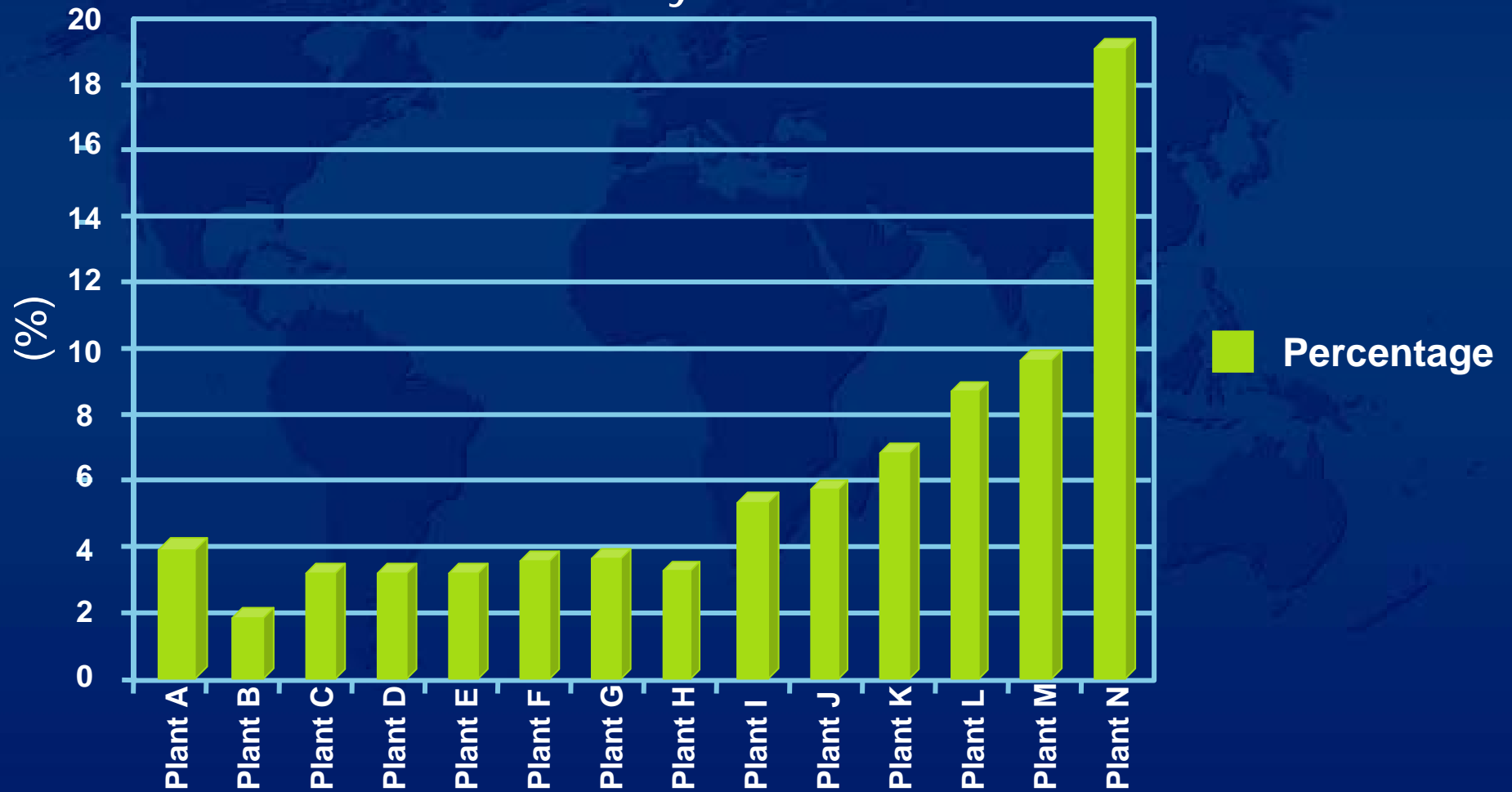
# Quantitative Methodologies

By Category



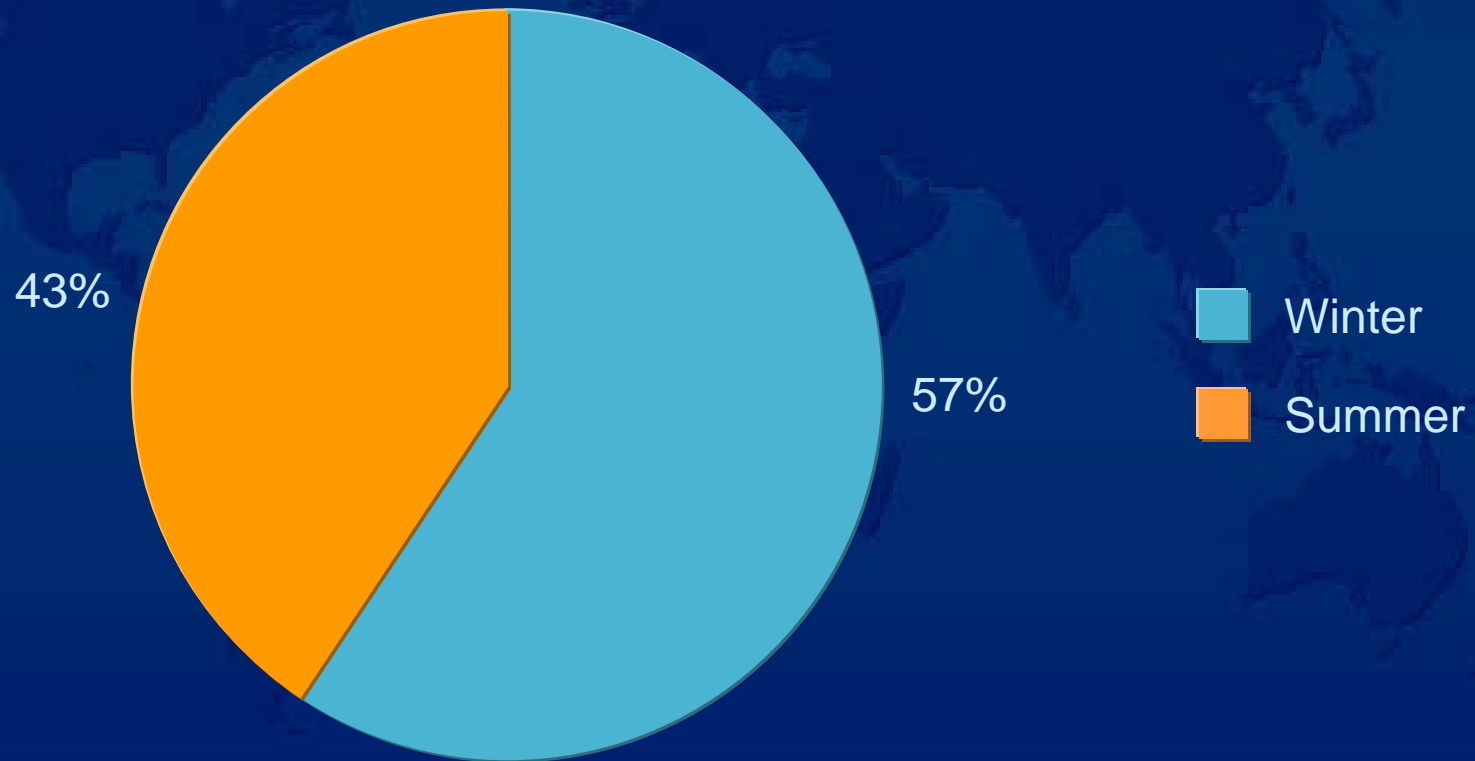
# Quantitative Methodologies

By Plant



# Quantitative Methodologies

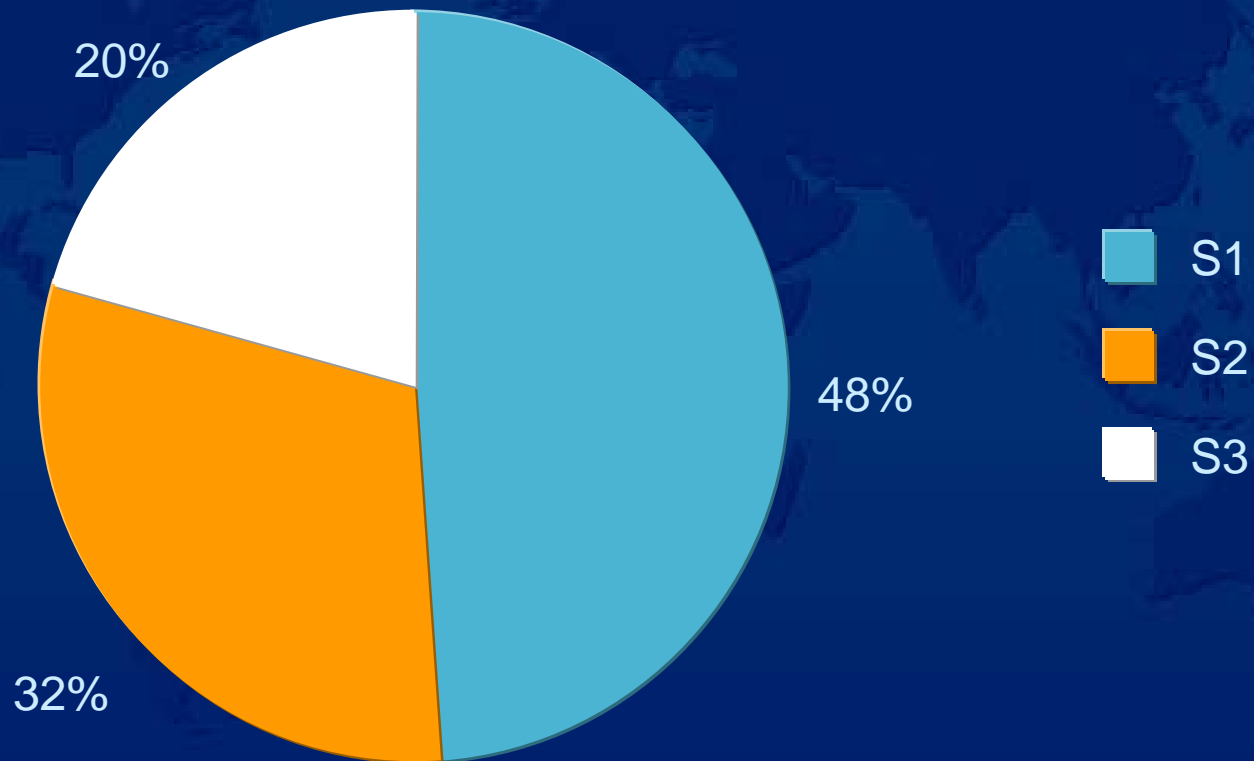
By Season





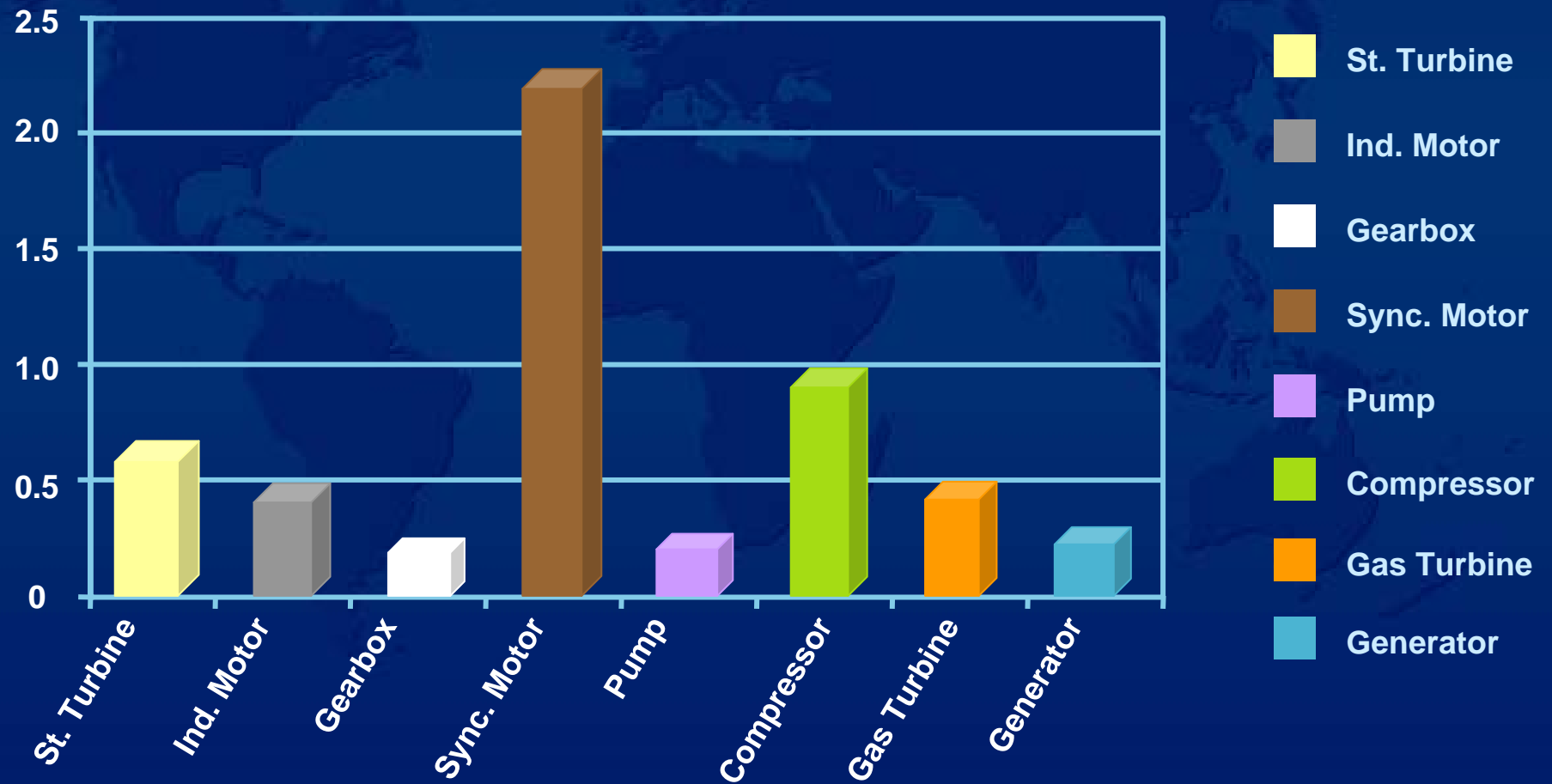
# Quantitative Methodologies

By Shift

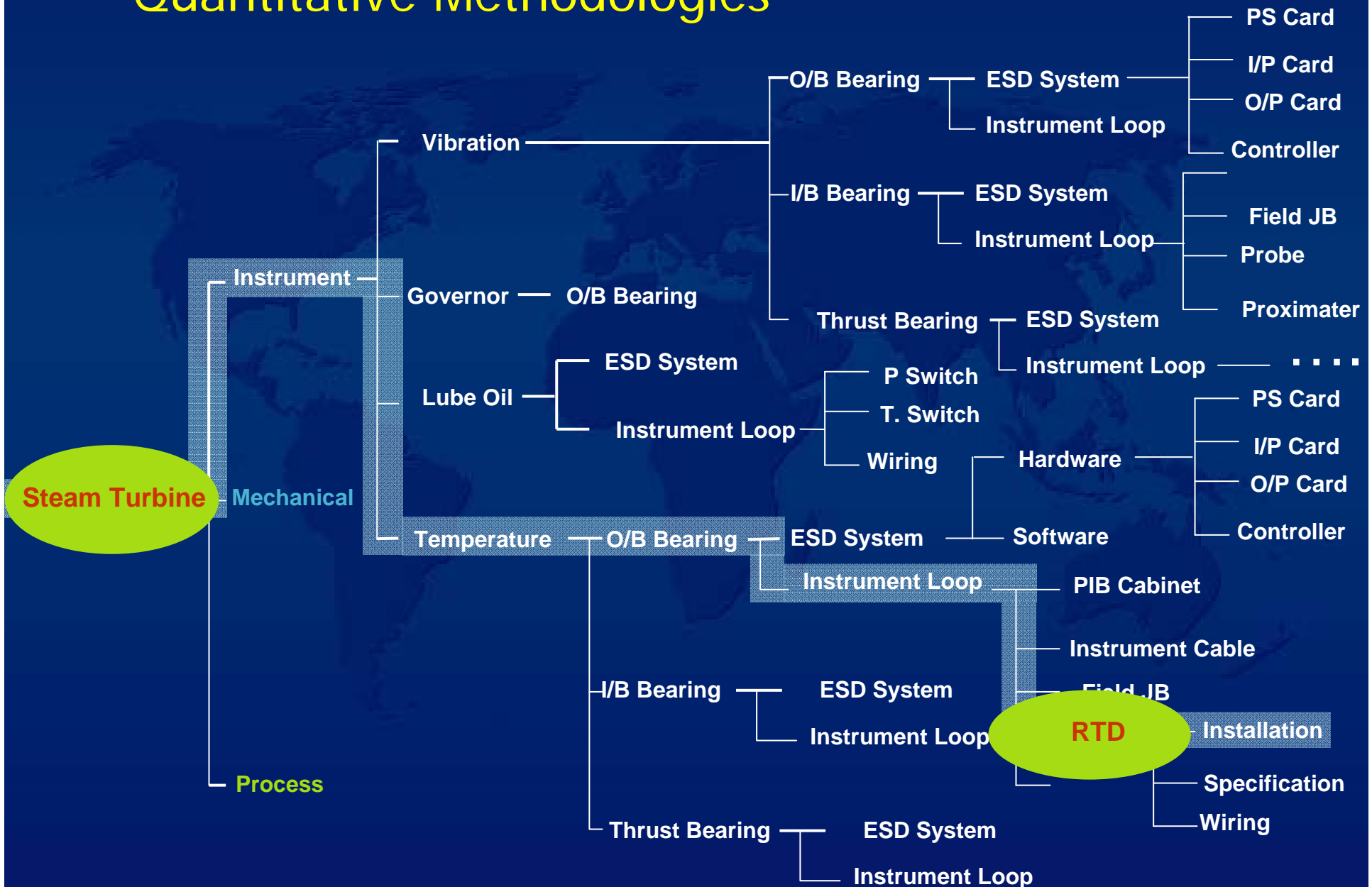


# Quantitative Methodologies

## By Equipment



# Quantitative Methodologies



# Quantitative Methodologies

- Established fault tree for all instrumentation upsets = 200
- Involved all specialized people in the fault tree identifications
- Prepared an educational Root Cause Analysis Class

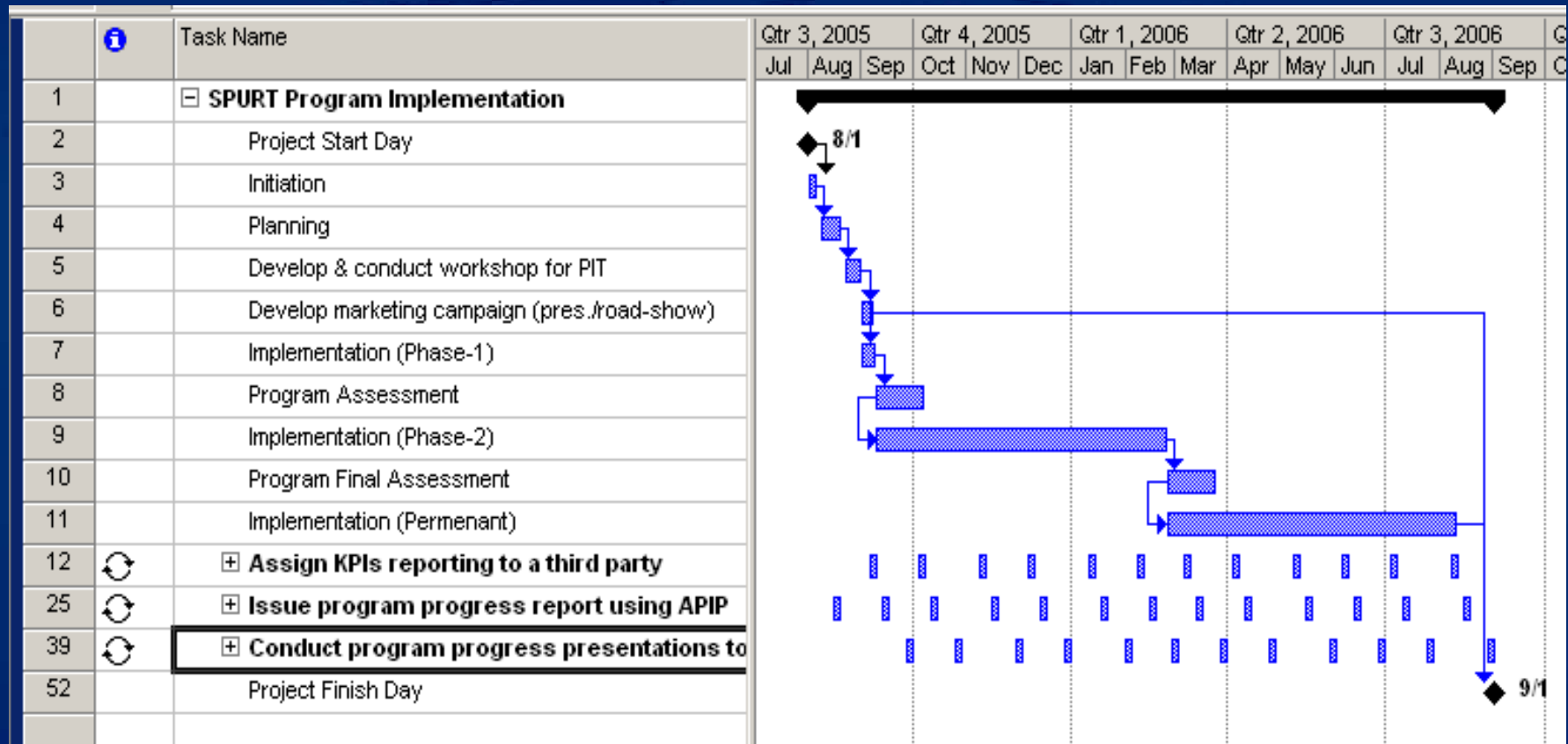
# Implementation Roadmap



# Qualitative Methodology



# RCA program Gant Chart



# Implementation Roadmap





## Conclusion

Managed to improve RCA program in the plants using qualitative & Quantitative techniques through an empowered project team under the supervision of the top management

## Lessons learned

1. Top management commitment
2. Multidiscipline and homogenous team
3. Empowered team under the supervision of one leader
4. Unlimited resources

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# Root Cause Analysis Program

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Thank you!

significant

process

spets **S P U**

review

team



**SPURT**

## Team Name & Mission

### **Mission:**

To provide feasible short and long-term recommendations aimed at minimizing Plants nuisance and unnecessary upsets using qualitative & quantitative methods

# Team Name & Mission

Microsoft Access - [Supervising Operations]

File Edit View Insert Format Records Tools Window Help

Type a question for help

**Section One Operations**

Report Number

**Equipment Details**

Division    
Plant #    
Equipment #    
Eqp Description

**Trip Time Details**

Day    
Month    
Year    
Hour    
Minute

**Shutdown Details**

Shutdown Source

If it was an ESD trip what was the

Alarm Tag   Time1

Trip Tag   Time2

Shutdown Result

If other equipment tripped what was it?

Was the Supervising Operator able to identify the trip primary cause?  Yes  No

08:03:41  
06/14/2004 Sat

Form View

Start Saudi Aramco Por... PI - ProcessBook... Inbox - Microsoft... Trip Reports Trip Report : Dat... Supervising Op... 8:03 AM

# Team Name & Mission

Microsoft Access - [Supervising Operations]

File Edit View Insert Format Records Tools Window Help

Type a question for help

**Badge Numbers and Signatures**

Operators Badge #  Operators Name  Date1

Foremans Badge #  Foremans Name  Date2

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**Section Two Maintenance**

Was the trip signal True or False?  True  False

If "True". what were the technicians findings?

If "False". what were the technicians findings?

What has been done to rectify the problem?

Is further help needed to diagnose the problem?  Yes  No

If "Yes". who is required?

MEandFA  Ops Eng  Rot Eqp Eng  DCS Eng  TSU

08:05:19  
06 Nov 2004 Sat

Form View

Start Saudi Aramco... PI - ProcessB... Inbox - Micro... Trip Reports Trip Report : ... Supervising ... Document1 - ... 8:05 AM

# Root Cause Analysis Section

## Built-in Library of fault trees

The image displays three overlapping software windows from a Root Cause Analysis tool:

- Components:** A window with a tree view on the left listing various components such as Potential Transformer, Control Card, Gate Drive, Air Circuit Breaker, Vacuum Circuit Breaker, SF6 Circuit Breaker, Oil Circuit Breaker, Gasket, Shaft, Overheating, Fracture, Design, Fabrication, Reaming misalignment, Flake off, Abrasive wear, Bent shaft, Shaft sleeve, Impeller wear ring, casing wear ring, Tilting Pad bearing, Journal sleeve bearing, and Antifriction bearing. The right side has a 'Selected Node Path' field containing 'Electrical', a 'Delete Selected Node' button, and an 'Add Component to the Selected Category' section with a 'Component Name' field and 'Add Component' and 'Update' buttons. Below that is an 'Add Fault to the Selected Component / Fault' section with a 'Fault Name' field and an 'Add Fault' button.
- Map RiskArea To Equip:** A window showing a tree view of 'Abqaiq Plants' with sub-nodes for 'Oil Division', 'NGL Division', 'Utilities Division', and 'SubStations'. The 'Utilities Division' is expanded to show plants like 'Plant 1100 (South Steam)', 'Plant 1111-1 (Power Plants)', 'Plant 1111-2 (A&W/Wales)', 'Plant 1111-3 (North Steam)', 'M 58 (Congen)', and 'Plant 500 (RO Plants)'. The right side has an 'Equipment List' with a scrollable list of columns (Column 2 to Column 19) and 'Add' and 'Remove' buttons.
- Equipment Form:** A window for editing equipment. The left side shows a tree view with 'Root Node' selected. The right side has a 'Selected Equipment Path' field containing 'Root Node', 'Update Selected Equipment', and 'Delete Selected Equipment' buttons. Below are fields for 'Equipment Name', 'Category' (set to 'NA'), 'SAP Number', and 'Type' (set to 'NA'). There are buttons for 'Add/Edit Components / Equipment', 'Add/Edit Specifications', and 'Add ESD Tags'. At the bottom, there are two green informational messages: '\* You can create new equipment under the root ONLY.' and '\*\* Use Drag and Drop to duplicate an equipment'. A 'Re Load Tree' button is at the very bottom.